Multiscale seismic characterization and monitoring of a potentially unstable rock mass: the Madonna del Sasso (NW Italy) rockfall

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Abstract

Active (e.g. surface refraction and cross-hole tomography) and passive (monitoring of microseismic events) seismic methods can provide a proper characterization of the inner structure of the rock mass and are key to the comprehension of the mechanisms enhancing the instability of rock masses.We propose a multiscale approach for the characterization of the potentially unstable granitic cliff of Madonna del Sasso (NW Italian Alps) integrating prospecting surveys, laboratory tests, long-term microseismic monitoring and numerical modeling. The complex 3-D fracture setting, the geometry of the unstable sector was achieved through field observations, photogrammetric geomechanical analysis and interpretation of on-site seismic surveys, which revealed to be fundamental for constraining the fracture geometry and opening at depth within the rock mass. Physical and mechanical properties of the investigated medium were obtained through laboratory tests on granite samples. Continuous monitoring of ambient vibration at the site (October 2013 - present) did not highlight irreversible changes in the rock mass properties precursory to an acceleration to failure. However, a strong thermal control was found to govern the stability of the cliff, with reversible seasonal opening and closing of fractures resulting from thermal contraction and expansion. Moreover, the vibration modes of the unstable sector were found to be strongly controlled by the complex 3-D geometry of the main fracture planes affecting the site. Detection and location of microseismic events within the prone-to-fall rock mass highlighted the concentration of low energy releases close to the major fracture planes. Microseismic monitoring at the laboratory scale of deformation and rupture processes is expected to further highlight the relationships between energy release, seismic signatures and seismic sources. Finally, finite element modeling on the 3-D geometry allowed an experimental validation and interpretation.

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